HICKOK

MODEL 270

FUNCTION GENERATOR

HICKOK THE HICKOK ELECTRICAL INSTRUMENT COMPANY
10514 Dupont Avenue • Cleveland, Ohio 44108

VIKING LABS / HONEYWELL
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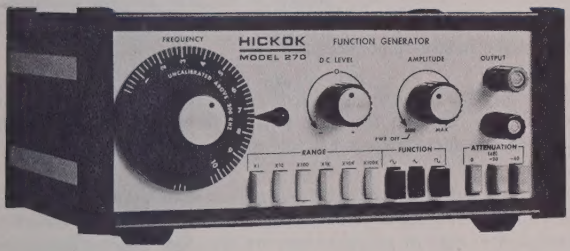

MODEL 270

FUNCTION GENERATOR

INSTRUCTION MANUAL

(Stock No. 2490-661)

The Hickok Electrical Instrument Company
10514 DUPONT AVENUE • CLEVELAND, OHIO 44108 • (216) 541-8060 • TWX: 810-421-8286

WARRANTY

IMPORTANT

The following warranty shall be void if the registration card is not properly completed and returned to the Hickok factory, post marked within ten days after date of purchase.

The Hickok Electrical Instrument Co. warrants this instrument of its manufacture to be free from defects in material and workmanship for a period of two years (24 months) from the date of original purchase, subject to the following conditions.

a. Any instrument found to be defective during the first twelve month period after date of purchase may be returned, transportation prepaid, to the factory for repair or, at our option, replacement without charge.

b. Any instrument found to be defective during the second twelve month period after date of purchase may be returned, transportation prepaid, to the factory for repair subject to a minimal handling charge for each time the instrument is returned. Contact the Hickok factory for information regarding this service charge.

This warranty does not apply to any of our products which have been repaired or altered by unauthorized persons, or which have been subject to misuse, negligence, or accident, or which have had the serial number altered, effaced or removed. Neither shall the warranty apply where a warranty registration card has not been properly completed and returned to us promptly after purchase. This warranty is in lieu of all other warranties whether expressed or implied.

RETURNING EQUIPMENT FOR REPAIR

Before returning any equipment for service, the factory must first be contacted, giving the nature of the trouble. Instructions will then be given for either correcting the trouble or returning the equipment. Upon authorization, this equipment should be forwarded directly either to:

Hickok
10514 Dupont Avenue
Cleveland, Ohio 44108

or

Supreme Electronics
1714 Carrollton Avenue
Greenwood, Mississippi 38930

or to a designated service station in your locality.

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SECTION I
GENERAL INFORMATION

INTRODUCTION

The Hickok Model 270 is a complete function generator capable of producing Sine, Square, and Triangle Waveforms to satisfy a great variety of testing applications. The output dc level of the waveforms is adjustable over a wide range, and selectable calibrated attenuators provide high and low level signals.

A P.C. Board connector accessible from the rear of Model 270 allows added versatility. By simply adding a resistor and a jumper wire, pulse and ramp waveforms may be obtained. AM and FM modulation of the basic waveforms is also possible, along with capabilities for Frequency Shift Keying and Phase Shift Keying. In addition, the rear connector provides access to the main output amplifier so that the Model 270 waveforms may be "mixed" with an external signal. The output amplifier may also be used alone as a wideband amplifier. In spite of its versatility, the Model 270 is an accurate, easy-to-use instrument that will provide many years of service.

SPECIFICATIONS

Basic Output Waveforms:	Sine, Square, Triangle
Frequency Range:	1 Hz to 1 MHz* in six pushbutton decade ranges: 1 Hz to 10 Hz 10 Hz to 100 Hz 100 Hz to 1 kHz 1 kHz to 10 kHz 10 kHz to 100 kHz 100 kHz to 1 MHz

*Typical (500 kHz guaranteed minimum upper frequency)

Frequency Accuracy:	±1% of full scale up to 200 kHz
Amplitude Flatness:	±0.1 dB from 20 Hz to 20 kHz; ±0.3 dB from 1 Hz to 100 kHz
Output Level:	0 to 24 volts peak-to-peak (8.5 Vrms) open circuit, protected against short circuits

Output Impedance:	600 ohms, ±5%, regardless of attenuator setting
Attenuators:	Step: (pushbutton), 0 dB, -20 dB, and -40 dB attenuations, ±0.5 dB accuracy (No button depressed disconnects output from output terminals)
	Continuous: from 0 to at least -40 dB attenuation. (Total range of step and continuous attenuators is -80 dB minimum)
DC Level:	Output dc level on all waveforms is continuously variable from -6 V to +6 V minimum at 0 dB attenuation
Frequency Stability (after 1/2 hour warm-up):	With line voltage: ±0.1% with 10% line change
	With temperature: ±0.1% per degree C from 0° to 50°C typical, ±0.3% per degree C max.
Amplitude Stability (after 1/2 hour warm-up):	With line voltage: ±0.5% with 10% line change
	With temperature: ±0.1% per degree C from 0° to 50°C typical, ±0.4% per degree C max.
Sine Wave Distortion:	Maximum total harmonic distortion from 20 Hz to 20 kHz is 1% typical, 1.5% max.
Square Wave Rise/Fall Time:	0.5 microseconds or less
Square Wave Symmetry:	5% maximum assymetry
Triangle Wave Linearity:	2% maximum non-linearity to 100 kHz

Rear Panel Inputs:

NOTE: The section on Special Functions must be thoroughly read before attempting to use the rear panel inputs.

PROTECTION: Any input on the rear panel may be connected to another Model 270 (or other unit with ±15 volt/600 ohm output) without damage. Connections to sources exceeding the limits of ±15 volts at 25 mA may cause permanent damage to the Model 270 if not limited with an external series impedance.

AM Input:	0 ±.5 volts = minimum output
	-4 volts = maximum output 0° phase
	+4 volts = maximum output 180° phase
	Input impedance = 20 k
FM Input:	8 volts peak to peak for full scale (10:1) frequency change
	Input impedance = 43 k
FSK Sync:	This pin is connected to FSK input to obtain pulses and ramps
FSK Control:	0 volts: normal (dial frequency)
	-6 volts: shifted frequency (frequency dependent upon value of external resistor connected between the FSK RESISTOR terminals on rear connector)
FSK RESISTOR Input:	Terminals for connecting external resistor to determine second frequency (when frequency shift keying), or pulse width, or ramp fall time
Mixer Input:	This pin provides access to the output amplifier, so that external signals may be summed with the normally available output waveforms
	Input impedance: 4.7 k. Maximum input required for full scale output amplitude swing is 0 to ±2 volts
Power Requirements:	105 to 125 Vac/210 to 250 Vac
Size:	8-1/2" w x 4" h x 6" d
Weight:	4 lbs

SECTION II
OPERATING INSTRUCTIONS FOR FRONT PANEL CONTROLS

AMPLITUDE CONTROL AND POWER SWITCH

Power is off when this control is turned completely counter-clockwise and "clicked" into position. Clockwise rotation turns the unit on and increases the amplitude of the waveform at the output jacks. Maximum output is about 24 volts peak to peak (8.5 Vrms) into an open circuit. The output impedance is 600 ohms. The attenuation range of the AMPLITUDE control is at least -40 dB (100:1 range).

The Model 270 case is tied to third-wire ground. The output terminals, however, are floating. The black terminal may be referenced up to 500 volts away from power line without damage to the instrument.

CAUTION: The output amplifier is directly coupled to the front panel terminals. DO NOT connect dc voltages greater than 5 volts across the output terminals, or internal damage may result.

If it is desired to connect the Model 270 to a point with a greater dc voltage than 5 volts, simply place a suitably sized coupling capacitor between the Model 270 output terminal and the desired point of connection. In addition, this technique can be used to ensure absolutely zero dc volts at the output.

The waveform appearing at the output terminals may be attenuated by a fixed divide of 0 dB, -20 dB or -40 dB, depending upon which pushbutton is depressed. (The output is disconnected if all buttons are out.) An additional -40 dB of variable attenuation is available in any position by using the AMPLITUDE control. The total dynamic range using both the fixed and variable attenuators is -80 dB.

The accuracy of the fixed attenuators is ±0.5 dB. Output impedance is 600 ohms ±5% for all settings of the AMPLITUDE and ATTENUATION controls.

NOTE: The pushbutton attenuators will also attenuate the dc level of the output.

FREQUENCY AND RANGE

The frequency of the output waveform is determined by the setting of the FREQUENCY dial and the selection of a RANGE button. For example, to obtain a 1,000 Hz output, set the FREQUENCY dial to 1 and depress the X1K pushbutton. Dial accuracy is 1% of full range. If manual sweeping of the output frequency is desired, the FREQUENCY dial will vary the frequency over at least a 100:1 range from stop to stop (Sine and Triangle Waves only).

DC LEVEL

The dc level of the output waveform may be varied from 0 to at least ±6 volts by using the DC LEVEL control. Thus, waveforms swinging entirely above (or below) ground are easily obtained. Note that the DC LEVEL control is independent of the AMPLITUDE control. That is, once the dc level of the basic output waveform is set, it will not vary when the AMPLITUDE control is adjusted, although the pushbutton attenuators will affect the dc level.

The DC LEVEL control is used when it is desired to insert a dc level into the output waveform to test circuits such as level shifters or dc level detectors. Occasionally the entire waveform is required to swing above (or below) ground when working with circuits operating from a single supply such as logic circuits. These circuits often require signal swings between ground and supply voltage. Offset signal swings may also be useful for modulation purposes when driving another function generator such as the Model 270.

FUNCTION

These three pushbuttons are used to select the basic waveform appearing at the output. The three waveforms are: 1) Sine, 2) Square, and 3) Triangle. Each signal has its unique uses. These will be described in subsequent paragraphs. In addition, when using the rear panel inputs the FUNCTION buttons are used to select the basic waveform to be modified.

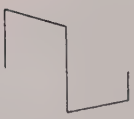
1. Sine Waves are generally used when a fundamental frequency (low in harmonics) is desired for checking frequency response gain or distortion in amplifiers, filters, IF stages, and other electronic networks. Audio systems and speakers may also be tested. Sine Waves are also useful in determining input and output impedances of various networks, and they can serve as modulation signals for RF signal generators or other function generators with modulation capability, such as another Model 270.

2. Square Waves are generally used when it is desired to test the response of an amplifier or electronic device to a step-change in voltage. Examples of such tests are rise and/or fall times and ringing. Square Waves are also useful for quick checks of overall bandwidth and phase

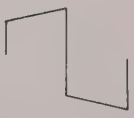
a) Square Wave passed unchanged

b) Loss in low freqs. No phase shift

c) Boost in low freqs. No phase shift



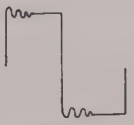
d) Low freq. phase shift (lagging)



e) Low freq. phase shift (leading)

f) Loss in low freq. and phase shift

g) Loss in high freqs.



h) Ringing

i) High freq. loss and low freq. phase shift

Figure 2. Waveforms

shift of coupling circuits. See Figure 2 for typical waveforms that may be found at the output of devices when a Square Wave has been applied to their input.

The Square Wave can also be used to determine the phase delay in delay lines.

3. Triangle Waves are useful in testing the gain linearity of amplifiers, oscilloscopes, chart recorders and, in general, whenever a linear change in voltage is required. It is easier to detect clipping in an amplifier with a Triangle Wave than with a Sine or Square Wave. Distortion may be viewed more easily since gain and frequency response irregularities show up as a "warpage" in the Triangle Wave's straight sides. The Triangle Wave's distinctive shape makes it easier to recognize in low level signal tracing, where Sine Waves are often camouflaged by hum or other noise sources.

SECTION III
REAR PANEL INPUTS AND APPLICATIONS

GENERAL

For those who require special waveforms other than the three basic waveforms provided from the front panel, or require special functions, such as modulation, frequency keying, etc., the Model 270 is provided with a P.C. Board connector extending out of the rear panel which permits modification of the front panel available waveforms to suit these special purposes. The input/output connections are identified on the rear panel of the Model 270.

CAUTION: DO NOT apply signal sources with less than 600 ohm output impedance or greater than ±15 volts output swing to the rear panel terminals, or internal damage may result. Addition of a resistor in series with the output will permit the use of generators with greater output capability than 15 volts at 600 ohms.

Note that one Model 270 may drive another without any possibility of damage. If a generator other than the Model 270 is to be used to drive these inputs, precautions should be taken to ensure that damage will not be done to the Model 270. Safe limits on signals applied to these pins are contained in the SPECIFICATIONS section of this book. There are a number of connectors readily available to match with the P.C. Board fingers. Below is a list of commonly available types and their manufacturers:

ELCO Series 6007 Card Edge Receptacle
No. 00-6007-010-940-002
CINCH Printed Circuit Edge Connector
No. 50-10A-20M
AMPHENOL 225 Series Edge Connector
No. 225-21011-401
AMPHENOL 143 Series Edge Connector
No. 143-010-01

FSK SYNC

The FSK SYNC terminal is used only when pulse or ramp waveforms are to be generated, in which case it must be connected to the FSK CONTROL pin. Refer to the paragraphs on PULSES and RAMPS. For normal operation, the FSK SYNC pin is left unconnected.

FSK CONTROL

The FSK CONTROL terminal is used for Frequency Shift Keying (FSK). This means the normal output frequency of any basic waveforms may be instantaneously changed to a different frequency, or brought back to normal again by using this control terminal. The output frequency is determined by the front panel FREQUENCY and RANGE controls when the FSK CONTROL pin is left unconnected,or grounded, or connected through at least 600 Ω to any voltage between ground and +15 volts. When the FSK CONTROL pin is connected to -6 volts, the output frequency now becomes a function of the resistance connected between the two FSK RESISTOR terminals. Any value between 0 and 100 k may be used with results as shown in the following table:

Range	X1	X10	X100	X1k	X10k	X100k
Normal Freq. (Hz)	1 to 10	10 to 100	100 to 1k	1k to 10k	10k to 100k	100k and up
Shifted Freq. (Hz)	1 to 100	10 to 1k	100 to 10k	1k to 100k	10k and up	100k and up
FSK Resistor	100k to 0Ω	100k to 0Ω	100k to 0Ω	100k to 0Ω	100k to 0Ω	100k to 0Ω

Refer to Figure 3 for a number of methods of activating the FSK terminal.

PULSES

To generate pulses, set the FUNCTION switch to , connect the FSK SYNC terminal to the FSK CONTROL terminal, and place a resistor between 0 and 100 k between the two FSK RESISTOR terminals. The output pulse width is determined by the value of resistance between the FSK RESISTOR terminals and the selected range. Attainable pulse widths are from approximately 1 μs to 0.5 sec. Resistances from 0 to 100 k ohms may be used with short pulses corresponding to low value resistors. The pulse repetition rate is varied by using the front panel FREQUENCY and RANGE controls. The front panel frequency calibration is no longer valid since the repetition rate will change as the pulse width is varied. Pulse trains with duty cycles ranging from 10% to 90% are attainable.

RAMPS

Ramps and sawtooths may be generated by making the rear connector connections discussed under PULSES, and placing the FUNCTION switches to . The fall time and thus the symmetry of the Triangle Wave are determined by the value of the external FSK resistor which can vary from 0 to 100 k. For example, if the resistor is small (or zero), then the fall time will be rapid, and a conventional sweep waveform will result. Since the frequency depends also on the fall time, the front

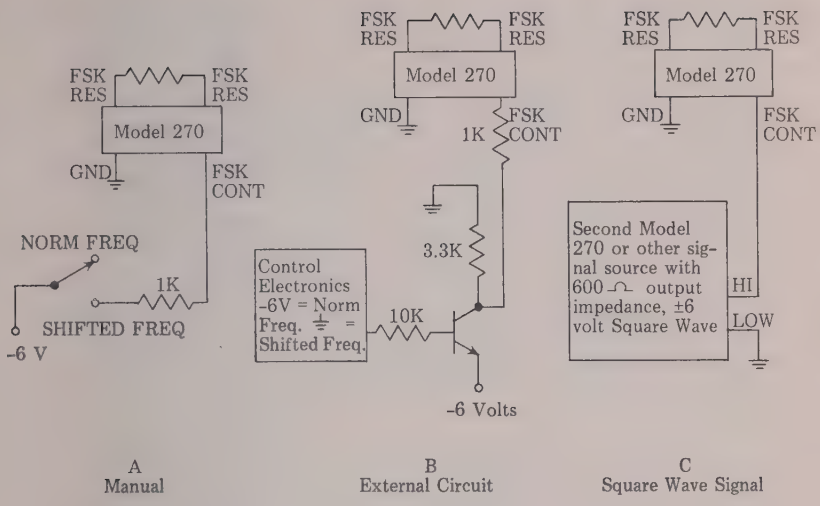


Figure 3. FSK Control Connections

panel frequency calibration is no longer valid. Experimentation may be used to determine the proper combination of external resistance, FREQUENCY dial setting and range selection necessary to produce satisfactory ramps for a particular application. Practical ramp frequencies are below 1 kHz.

The ramp waveforms are useful as external sweep signals for oscilloscopes or to generate linear frequency sweep outputs for driving signal generators, such as another Model 270 which has FM inputs.

FREQUENCY MODULATION

The output frequency of any basic waveform coming from the Model 270 may be swept over each range by using the FM INPUT terminal on the rear panel connector. The easiest way to accomplish this is the capacitor coupled method.

Any suitable signal generator may be used with a coupling capacitor connected as shown between the generator output and the FM INPUT pin on the Model 270. The input impedance of the FM INPUT pin is 43 kΩ. Of course, if the external signal generator already has a capacitor coupled output, then no additional coupling capacitor is necessary. The center frequency of the Model 270 output waveform is determined using the front panel FREQUENCY and RANGE controls. The amplitude, shape, and frequency of the external signal fed into the FM input

determines the amount of frequency deviation and the nature of modulation. An 8 volt peak-to-peak signal is required for a 10-to-1 frequency change.

In rare instances where very low frequency FM modulation is desired or when the Model 270 is to be used as a voltage controlled oscillator (VCO), it may be necessary to directly couple the external signal generator as shown in Figure 4. It is necessary that the external generator has an adjustable negative dc level since the Model 270 output frequency will change if a dc level or ground is impressed upon the FM INPUT pin. A second Model 270 is ideal for such applications since its DC LEVEL control can be adjusted as low as -6 volts. Set the dc level of the external signal generator to -5 or -6 volts. By adjusting either the dc level of the external generator or the FREQUENCY dial of the Model 270, the desired center frequency can be obtained. Monitoring the Model 270 output on an oscilloscope is necessary since the FREQUENCY dial becomes uncalibrated when a dc level is connected to the FM INPUT terminal.

Capability of FM modulation allows the Model 270 to be used to test certain FM discriminators or to have a swept frequency output for testing and aligning IF strips, amplifiers, filters, speakers and tape recorders. Use as a voltage controlled oscillator (VCO) facilitates experimentation with certain types of analog-to-digital convertors and phase-locked loops.

AMPLITUDE MODULATION

The AM INPUT terminal allows the amplitude of the Sine or Triangle Waves to be modulated from 0 to 100%. Applying ground (±.5 volt) to the AM INPUT pin attenuates the output to zero. As the bias is decreased toward -4 volts, the output amplitude will rise to a maximum (set by the

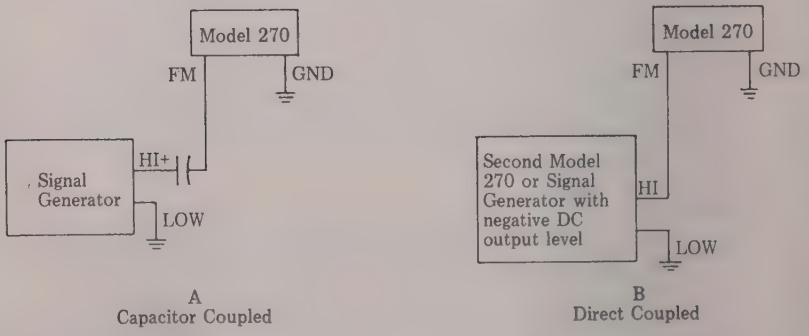


Figure 4. Frequency Modulation Connections

front panel AMPLITUDE control). Leaving the AM INPUT pin floating allows the front panel AMPLITUDE control to operate normally. Alternatively, the output amplitude will be affected by applying a voltage varying from ground to +4 volts; ground represents minimum output and +4 volts allows the output to reach a maximum. The difference in this method is that the output waveform is shifted in phase by 180° compared to the output when the AM INPUT pin was held below ground. This property of the AM input makes it suitable for phase shift keying (see next section).

Refer to Figure 5 for the proper methods connecting signal generators to the AM INPUT pin for amplitude modulation ranging from 0 to 100%.

If the external generator is capacitor coupled to the Model 270, then a 22 k resistor between the AM INPUT and COMMON is required. For generators with a transformer output, a series connected 22 k resistor is used as shown. The external generator may also be directly coupled into the Model 270 AM input if the output can be adjusted for a negative dc offset of about -1.5 volts.

Dc coupling the external signal into the Model 270 is required if very low frequency modulation is desired. The input impedance of the AM pin is about 25 k ohms. Full modulation requires a signal of approximately 4 volts peak-to-peak. The overall output amplitude of the modulated signal is still controlled by the AMPLITUDE control. The DC LEVEL control also operates normally.

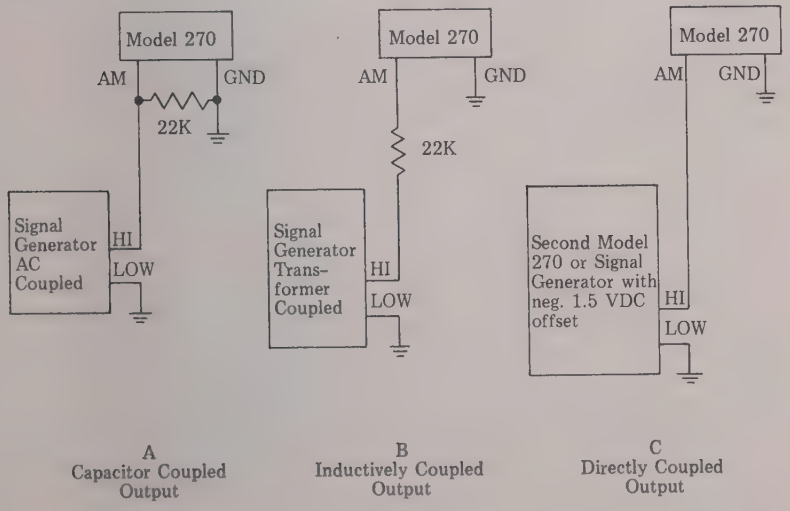


Figure 5. Signal Generator Connections for Amplitude Modulation

The AM capability of the Model 270 allows testing of broadcast RF, IF strips and AM demodulators. Using a Square Wave to gate the output between full on and full off yields a "tone burst" capability for testing transient amplitude responses of filters, amplifiers, speakers and other electronic circuits.

PHASE SHIFT KEYING

Phase shift keying is realized through the AM INPUT terminal. Applying a Square Wave swinging symmetrically about ground (+ 4 volts max.) will cause the output phase of either the Sine or Triangle Wave to shift between 0° and 180°. The output amplitude will depend on the peak-to-peak magnitude of the PSK signal at the AM INPUT pin, as well as the setting of the front panel AMPLITUDE control.

Phase-sensitive circuits may be checked out using the PSK capability of the Model 270.

MIXING

Access to the input of the output power amplifier is accomplished via the MIXER INPUT terminal. It is possible to sum together the normally available output waveform (including the FM and AM waveforms) with an external signal. This outside source can range from zero to ±2 volts before the Model 270 output begins to clip. If the external signal contains dc, it should be capacitively coupled into the mixer input. The input impedance is 4.7 kΩ.

When not used, the MIXER INPUT pin is left disconnected. The front panel AMPLITUDE control affects only the magnitude of the internally generated waveform, while the external signal source must be externally adjusted. The front panel DC LEVEL control operates in the normal way.

Mixing capability allows testing of intermodulation distortion in amplifiers and speakers. Also, filters may be checked for high, low, or band-pass frequency response.

If desired, the Model 270 output amplifier may be used independently of the rest of the unit. To do this, first turn the AMPLITUDE control fully counter-clockwise, short of turning the unit off. Then partially depress a non-depressed FUNCTION button such that all FUNCTION buttons become disengaged (in the out position). This disconnects the output amplifier from the internal signal circuitry. Using the MIXER INPUT pin for access, the unit may now be used as a fixed gain inverting amplifier. The gain is approximately 6. Typical bandwidth is dc to 2 MHz with a 200 ns risetime. The front panel DC LEVEL control still operates normally.

SECTION IV
MAINTENANCE AND CALIBRATION

GENERAL

The Model 270 has been manufactured using the latest semiconductor devices and techniques that electronic technology has to offer. It has been designed for long, reliable, and trouble-free service as indicated by our two-year warranty.

Should difficulty be encountered, Hickok maintains a complete service facility to render accurate, timely and reliable service of our products.

A troubleshooting procedure is not presented in this manual due to the complexity of the integrated circuits employed and the fact that test equipment necessary for proper servicing is not generally available in the field. If field calibration is required, the following procedures should be implemented in the order in which they are presented.

EQUIPMENT REQUIRED

Hickok Model 3300 DMM or equivalent
Hickok Model 5000 Oscilloscope or equivalent, with probe or test leads
1 MHz Frequency Counter
Harmonic Distortion Analyzer (Heathkit IM-58)

OFFSET ADJUSTMENTS

1. Output Amplifier

   a. Set all of the FUNCTION switches (Sine, Triangle, and Square) out.

   b. Set the AMPLITUDE control at its minimum counter-clockwise position, but not to OFF.

   c. Set the DMM to read dc volts and connect it to the front panel terminals of the 270.

   d. Depress the 0 dB ATTENUATOR switch.

   e. Adjust the front panel DC LEVEL control until the output is within 100 mV of ground.

f. The indicator on the knob should be pointing straight up toward the zero mark on front panel. If not, carefully reposition the knob on the shaft.

g. Check the range of the DC LEVEL control by turning the knob to each of its extremes. The adjustment range should be greater than ±6 volts. Return the knob to its zero volts position.

2. Square Wave

a. Turn the FREQUENCY dial to 5 and push the X1K button.

b. Depress the Square Wave FUNCTION switch and verify that the 0 dB ATTENUATION button is depressed.

c. Verify that DC LEVEL control is pointing toward zero, and set the AMPLITUDE control about 2/3 of the way clockwise.

d. Use the oscilloscope to observe the presence of a Square Wave before proceeding. The amplitude should be greater than 10 volts peak-to-peak.

e. Turn the AMPLITUDE control to its minimum position, but not to OFF, and note the dc output level with the DMM.

f. Turn the AMPLITUDE control 2/3 of the way clockwise, and adjust R133 until the output dc level is within 100 mV of the reading taken in Step 3. (This adjustment sets Square Wave symmetry about ground.)

SINE WAVE ADJUSTMENTS

1. Distortion

a. Verify that the FREQUENCY dial is set to 5 and that the X1K button is pushed.

b. Make sure the 0 dB ATTENUATION switch is depressed.

c. Verify that the DC LEVEL control is pointing toward zero and that the AMPLITUDE control is 2/3 of the way clockwise.

d. Press the Triangle FUNCTION switch and note the amplitude of the waveform using the oscilloscope. (Amplitude should be greater than 10 volts peak-to-peak.)

e. Press the Sine FUNCTION switch and adjust R131 until the Sinusoidal Waveform is about the same amplitude as the Triangle Waveform observed in Step d.

f. Connect the harmonic distortion analyzer to the output of the Model 270 and readjust R131 for minimum distortion, which should be less than 1.5%. Disconnect the distortion analyzer.

2. Offset

a. Verify that the FREQUENCY dial is set to 5, the X1K button is pushed, the 0 dB ATTENUATOR switch is depressed, and that the DC LEVEL control is pointing toward zero.

b. Turn the AMPLITUDE control to its minimum position, but not to OFF, and note the dc output level with the DMM.

c. Turn the AMPLITUDE control 2/3 of the way clockwise, and adjust R106 until the output dc level is within 100 mV of the reading taken in Step b.

GAIN

1. Verify that the FREQUENCY dial is set to 5, the X1K button is pushed, and the 0 dB ATTENUATION switch is depressed.

2. Select the Triangle FUNCTION.

3. With the AMPLITUDE control in its most minimum position, check the output dc voltage with the DMM and verify that it is within 100 mV of ground. If not, readjust the DC LEVEL control.

4. Turn the AMPLITUDE control to its maximum clockwise position.

5. Monitor the output waveform using the oscilloscope and adjust R164 until the peak of the wave is about 0.5 volts away from clipping. (12 volt peak, or more.)

6. Switch to Sine Waves and check for any amplitude increase in the waveform. If any is present, readjust R164 again until the peak of the wave is about 0.5 volt away from clipping.

FREQUENCY CALIBRATION

NOTE: The X1K range calibration adjustment affects all of the other frequency adjustments and must be performed first.

1. Rotate the FREQUENCY dial fully counter-clockwise. The front panel indicator should coincide exactly with the major reference mark on the dial. If not, loosen dial and readjust.

2. Verify that the DC LEVEL control is pointing toward zero and that the 0 dB ATTENUATION button is depressed.

3. Attach the counter to the 270 output jacks, select the Square Wave FUNCTION switch and adjust the output to a convenient amplitude.

4. Set the FREQUENCY dial exactly to 10 and select the X1K range.

5. Adjust R112 until the counter reads between 9,950 Hz and 10,050 Hz, preferably as close to 10,000 Hz as possible.

6. Turn the FREQUENCY dial until the front panel indicator coincides exactly with the 1 on the dial.

7. The frequency should be between 900 Hz and 1,100 Hz. (Ideally, it should be 1,000 Hz.) If not, proceed as follows.

8. If the frequency in Step 7 was high (i.e., greater than 1,100 Hz) perform the following:

   a. Rotate the FREQUENCY dial fully counter-clockwise.

   b. Loosen the dial and readjust it so that the minor reference mark to the RIGHT of the major mark lines up with the front panel indicator. Tighten the dial.

   c. Repeat Steps 4, 5, and 6.

   d. The observed frequency should now be between 900 Hz and 1,100 Hz. If it is not, again rotate the FREQUENCY dial fully counter-clockwise, then loosen and readjust the dial until the front panel indicator lines up at an intermediate position slightly away from the reference point last used. (Move slightly to the LEFT if the frequency was still low or slightly to the RIGHT if the frequency was too high.) Repeat Steps 4, 5, and 6.

   e. The frequency should now be between the 900 Hz to 1,000 Hz limit. If not, repeat Step d until a suitable reference point is found.

9. Turn the FREQUENCY dial until the front panel indicator coincides with the 10 on the dial, and the output frequency falls between 9,950 Hz and 10,050 Hz.

10. Select the X100 range and adjust R122 until the output frequency reads between 995 Hz and 1,005 Hz, preferably as close to 1,000 Hz as possible.

11. Select the X10 range and adjust R120 until the output frequency reads between 99.5 Hz and 100.5 Hz, preferably as close to 100 Hz as possible.

12. Change to a period measurement and select the X1 range. Adjust R118 for a period between 99.5 ms and 100.5 ms, preferably as close to 100 ms as possible.

13. Switch the counter back to frequency measurement and select the X10K range. Adjust R125 for a reading between 100,500 Hz and 99,500 Hz, preferably as close to 100,000 Hz as possible.

14. Turn the FREQUENCY dial until the front panel indicator coincides exactly with the 1 on the dial.

15. Select the X100K range and adjust R127 until a reading between 101,000 Hz and 99,000 Hz is obtained, preferably as close to 100,000 Hz as possible.

ATTENUATOR CHECK

1. Set the DMM to read ac volts and connect it to the 270 output jacks.

2. Verify that the DC LEVEL control is pointing toward zero, then set the FREQUENCY dial to 1, depress the X1K range button and select the Sine FUNCTION.

3. Verify that the 0 dB ATTENUATION switch is pushed, and set the output amplitude between 7.92 and 8.08 Vrms. (8 volts ±1%.)

4. Press the -20 dB ATTENUATION pushbutton. The output amplitude should drop to 0.74 to 0.86 Vrms.

5. Press the -40 dB ATTENUATION pushbutton. The output amplitude should drop to 0.074 to 0.086 Vrms.

SECTION V
PARTS LIST
MODEL 270
FUNCTION GENERATOR
STYLE NO. 902-517

When ordering parts be sure to give the reference designation, description, and the Hickok part number as listed in the following table. Also include the model and serial number of the equipment. There is a minimum billing charge of $5.00 for all parts orders.

REF DESIG.	NOTES	DESCRIPTION	HICKOK PART NO.
AR101		INTEGRATED CIRCUIT: LM741CN	9800-57
C101		CAPACITOR, FIXED, ALUMINUM ELECTROLYTIC: 470 uf, -10% +100%	3085-505
C102		Same as C101	
C103		CAPACITOR, FIXED, BEAD TANTALUM: 4.7 uf, 20%, 35 volts	3085-471
C104		CAPACITOR, FIXED, BEAD TANTALUM: 10 uf, 10%, 25 volts	3085-504
C105		CAPACITOR, FIXED, METALLIZED MYLAR: .1 uf, 10%, 250 volts	3090-103
C106		CAPACITOR, FIXED, DIPPED MICA: 1000 pf, 5%, 500 volts	3096-549
C107		Same as C103	
C108		CAPACITOR, FIXED, CERAMIC: .01 uf, disc type	3111-527
C109		Same as C108	
C110		CAPACITOR, FIXED, CERAMIC: 100 pf, disc type	3111-516

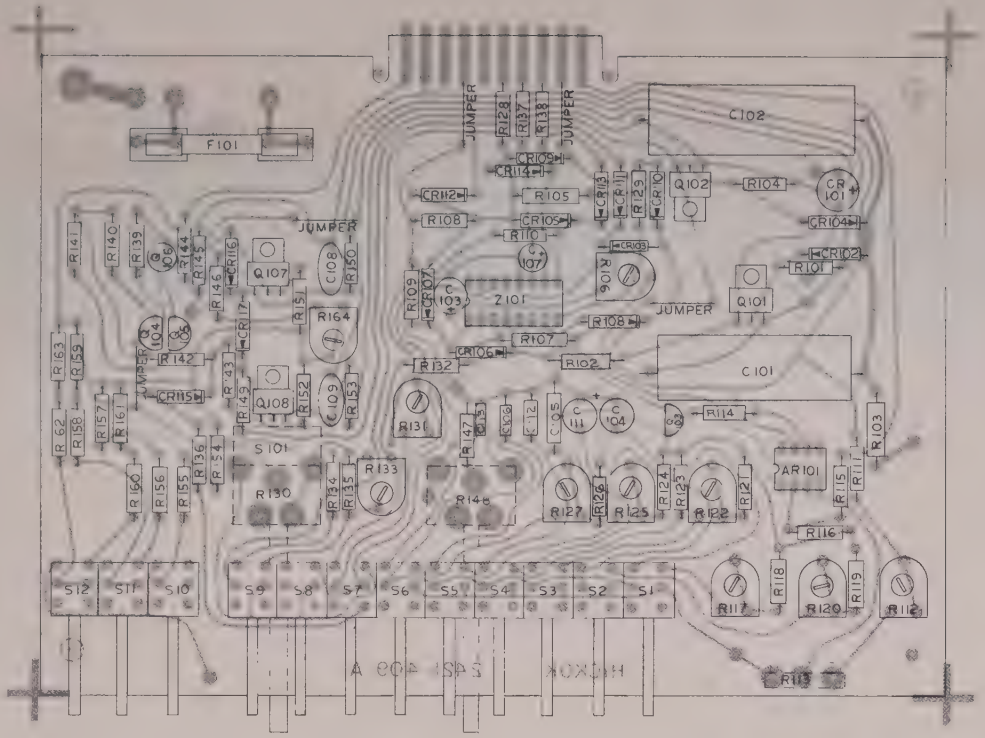
REF DESIG.	NOTES	DESCRIPTION	HICKOK PART NO.
C111		CAPACITOR, FIXED, BEAD TANTALUM: 1 uf, 10%, 25 volts	3085-506
C112		CAPACITOR, FIXED, METALLIZED MYLAR: .01 uf, 10%, 250 volts	3090-101
C113		CAPACITOR, FIXED, DIPPED MICA: 330 pf, 5%, 500 volts	3096-537
CR101		RECTIFIER: diode bridge VE18	18150-81
CR102		SEMICONDUCTOR DEVICE: diode 1N5740B	3870-309
CR103		SEMICONDUCTOR DEVICE: diode, 6.2 volts ±5%, 400 MW, 1N5731B zener	3870-302
CR104		Same as CR102	
CR105		Same as CR103	
CR106 thru CR114		SEMICONDUCTOR DEVICE: diode 1N914	3870-175
CR115		SEMICONDUCTOR DEVICE: diode, 10 volts ±5%, 1N5736B	3870-319
CR116		Same as CR106	
CR117		Same as CR106	
DS101		LAMP: LED	12270-129
F101		FUSE: 1/4 amp, SLO-BLO, 250 volts	6900-78
J101		BINDING POST: red color	2360-107
J102		BINDING POST: black color	2360-106
P101		CORD: line	3675-49
Q101		TRANSISTOR: NSD 104 NPN, general purpose, medium power	20861-387
Q102		TRANSISTOR: D41D2 PNP, general purpose, medium power	20861-337
Q103		TRANSISTOR: A139 NPN, silicon	20861-316
Q104		Same as Q103	
Q105		Same as Q103	

REF DESIG.	NOTES	DESCRIPTION	HICKOK PART NO.
Q106		TRANSISTOR: 2N3906, PNP, silicon	20861-139
Q107		Same as Q101	
Q108		Same as Q102	
R101		RESISTOR, FIXED, DEPOSITED CARBON: 1K ohms, 5%, 1/4 watt	18470-102
R102		RESISTOR, FIXED, COMPOSITION: 240 ohms, 5%, 1/2 watt	18411-241
R103		RESISTOR, FIXED, COMPOSITION: 2.2K ohms, 10%, 1/2 watt	18412-222
R104		Same as R101	
R105		Same as R102	
R106		RESISTOR, VARIABLE: 22K ohms, 20%, horizontal mtg	16925-847
R107		RESISTOR, FIXED, DEPOSITED CARBON: 150K ohms, 5%, 1/4 watt	18470-154
R108		RESISTOR, FIXED, DEPOSITED CARBON: 47K ohms, 5%, 1/4 watt	18470-473
R109		RESISTOR, FIXED, DEPOSITED CARBON: 30K ohms, 5%, 1/4 watt	18470-303
R110		RESISTOR, FIXED, DEPOSITED CARBON: 56K ohms, 5%, 1/4 watt	18470-563
R111		RESISTOR, FIXED, DEPOSITED CARBON: 5.1K ohms, 5%, 1/4 watt	18470-512
R112		RESISTOR, VARIABLE: 10K ohms, 20%, horizontal mtg	16925-820
R113		RESISTOR, VARIABLE: 5K ohms, 20%	16925-849
R114		Same as R101	
R115		RESISTOR, FIXED, DEPOSITED CARBON: 43K ohms, 5%, 1/4 watt	18470-433

REF DESIG.	NOTES	DESCRIPTION	HICKOK PART NO.
R116		RESISTOR, FIXED, DEPOSITED CARBON: 10K ohms, 5%, 1/4 watt	18470-103
R117		RESISTOR, FIXED, DEPOSITED CARBON: 4.7K ohms, 5%, 1/4 watt	18470-472
R118		RESISTOR, VARIABLE: 5K ohms, 20%, horizontal mtg	16925-846
R119		Same as R117	
R120		Same as R118	
R121		Same as R117	
R122		Same as R118	
R123		RESISTOR, FIXED, METAL FILM: 6.65K ohms, 1%, 1/8 watt	18554-212
R124		Same as R117	
R125		Same as R118	
R126		RESISTOR, FIXED, DEPOSITED CARBON: 1.5K ohms, 5%, 1/4 watt	18470-152
R127		RESISTOR, VARIABLE: 2.2K ohms, 20%, horizontal mtg	16925-854
R128		RESISTOR, FIXED, DEPOSITED CARBON: 240 ohms, 5%, 1/4 watt	18470-241
R129		RESISTOR, FIXED, DEPOSITED CARBON: 750 ohms, 5%, 1/4 watt	18470-751
R130		RESISTOR, VARIABLE: 25K ohms, 10%, 1/3 watt, with rotary switch attached	16925-851
R131		RESISTOR, VARIABLE: 500 ohms, 20%, horizontal mtg	16925-848
R132		RESISTOR, FIXED, DEPOSITED CARBON: 8.2K ohms, 5%, 1/4 watt	18470-822
R133		Same as R118	

REF DESIG.	NOTES	DESCRIPTION	HICKOK PART NO.
R134		RESISTOR, FIXED, DEPOSITED CARBON: 1.2K ohms, 5%, 1/4 watt	18470-122
R135		RESISTOR, FIXED, DEPOSITED CARBON: 3.3K ohms, 5%, 1/4 watt	18470-332
R136		RESISTOR, FIXED, DEPOSITED CARBON: 18K ohms, 5%, 1/4 watt	18470-183
R137		RESISTOR, FIXED, DEPOSITED CARBON: 3.0K ohms, 5%, 1/4 watt	18470-302
R138		RESISTOR, FIXED, DEPOSITED CARBON: 470 ohms, 5%, 1/4 watt	18470-471
R139		Same as R137	
R140		RESISTOR, FIXED, DEPOSITED CARBON: 300 ohms, 5%, 1/4 watt	18470-301
R141		Same as R140	
R142		Same as R132	
R143		RESISTOR, FIXED, DEPOSITED CARBON: 2.2K ohms, 5%, 1/4 watt	18470-222
R144		Same as R117	
R145		RESISTOR, FIXED, DEPOSITED CARBON: 5.6K ohms, 5%, 1/4 watt	18470-562
R146		RESISTOR, FIXED, DEPOSITED CARBON: 20K ohms, 5%, 1/4 watt	18470-203
R147		Same as R136	
R148		RESISTOR, VARIABLE: 5K ohms, 30%, 1/2 watt	16925-852
R149		Same as R135	

REF DESIG.	NOTES	DESCRIPTION	HICKOK PART NO.
R150		RESISTOR, FIXED, DEPOSITED CARBON: 33 ohms, 5%, 1/4 watt	18470-330
R151		Same as R150	
R152		Same as R150	
R153		Same as R150	
R154		Same as R140	
R155		Same as R140	
R156		Same as R145	
R157		RESISTOR, FIXED, DEPOSITED CARBON: 390 ohms, 5%, 1/4 watt	18470-391
R158		RESISTOR, FIXED, DEPOSITED CARBON: 330 ohms, 5%, 1/4 watt	18470-331
R159		Same as R158	
R160		Same as R109	
R161		Same as R109	
R162		RESISTOR, FIXED, DEPOSITED CARBON: 560 ohms, 5%, 1/4 watt	18470-561
R163		RESISTOR, FIXED, DEPOSITED CARBON: 47 ohms, 5%, 1/4 watt	18470-470
R164		Same as R106	
S1 thru S9		SWITCH: pushbutton, 9 station	19910-251
S10 thru S12		SWITCH: pushbutton, 3 station	19910-250
S13		Part of R130	
T101		TRANSFORMER: power	20800-430
Z101		INTEGRATED CIRCUIT: monolithic function generator	9800-142



PARTS LOCATION DIAGRAM
MODEL 270

ALT.	DRAWING NUMBER
C B A	902-517 W